

Johnson (W. B.) ad

INTUBATION OF THE LARYNX,

WITH A

REPORT OF EIGHTEEN CASES,

BY

WALTER B. JOHNSON, M. D.,

SURGEON TO THE PATERSON EYE AND EAR INFIRMARY, PATERSON, N. J.

presented by the author —

Reprinted from the Transactions of the Medical Society of New Jersey, 1891.



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Intubation of the Larynx, with a Report of Eighteen Cases.

In preparing the paper on Intubation which I have the honor of presenting at this meeting of the Medical Society of New Jersey, an effort has been made after a careful study of the literature, to briefly and comprehensively arrange the opinions and observations of prominent workers in the field. The operation has a great future, and is destined to come into more general use than tracheotomy ever could have done, although it is not intended to, and never can, entirely supersede the old operation, which may still be performed when indicated.

Should the compilations under separate headings here appended be of service to the practitioners of our own, or other States, who have recently undertaken the study or performance of Intubation, the effort will certainly be fruitful in the consequent relief of suffering and saving of life.

HISTORY.

Effort at the removal of pseudo-membrane from the larynx, in cases of stenosis with accompanying dyspnœa, and attempts to relieve patients temporarily by catheterization of the larynx, are recorded in early medical his-

tory. In the time of Hippocrates and until the discovery of the operation for bronchotomy by Asclebiades, about 100 B. C., the laryngeal brush, probang and forceps, were advocated for the removal of membrane from the larynx; their use was reported to have afforded temporary relief. Catheterization of the larynx was also strongly recommended and was said to have saved lives that would otherwise have been lost.

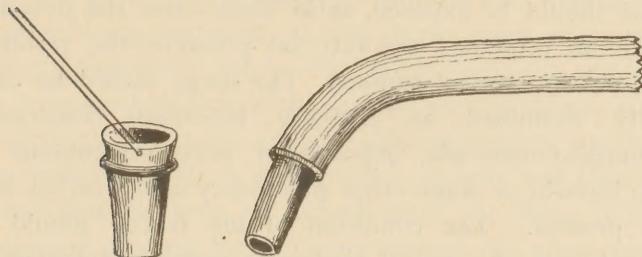
The operation for bronchotomy was received so favorably by the medical profession in general, that from the time of its first introduction it seems to have superceded all other procedures, and no account of any of the earlier methods appears in medical literature until revived by Chaussier in 1780. From 1780 until 1858, different methods of catheterization were advocated by numerous practitioners in various countries; none of these procedures, however, secured any extended professional endorsement or trial.

In 1858 Bouchut of Paris devised an operation which he called tubage of the larynx. In the light of subsequent developments his procedure appears to have been a step in advance, being the first and only record of a proposition to introduce a short tube, intended to remain within the larynx, and to permit closure of the epiglottis and the act of deglutition. His enthusiasm led him to present premature reports, and to make claims which he could not substantiate. Unfortunately his disposition was such, that in combating the objections of Trosseau and the committee of the French Academy of Medicine, appointed to investigate and report, he incurred their enmity. They reported adversely, and thereafter his operation was entirely lost sight of and forgotten. Bouchut reported in all ten cases, three of which were said to have resulted successfully. He had beyond all

peradventure demonstrated the possibility of introducing a short tube into the larynx, which positively relieved dyspnoea and was capable of being retained for a considerable length of time without serious discomfort.

The instruments used by Bouchut were crude and unscientific in construction. The tube was a cylinder, shaped like a tailor's thimble, less than one inch in length and did not reach into the trachea. It had two collars near the upper edge between which the cords were to rest and thus aid in its retention. It had an eyelet near the edge through which a thread was passed and left while the tube remained in the larynx. The thread was attached to prevent swallowing, and also to permit removal of the tube when necessary.

Plate No.1



Bouchut Tube and Introducer.

The introducer shaped like an uethral sound fitted into the tube and could be easily detatched from it.

The sketch of the Bouchut instruments here presented was kindly furnished by Dillon Brown, M.D., of New York. A very complete history of catheterization, tubage intubation, etc., has been written by him.*

* Transactions Ninth International Medical Congress. Vol. III, Diseases of Children.

In 1880 intubation of the larynx was introduced at the New York Foundling Asylum by Joseph O'Dwyer, M.D., of New York, who, after years of study and experiment and without any knowledge of previous efforts in the same direction having been made, perfected the operation and the instruments, and presented them to the medical profession. His painstaking labor, and his modesty, have fortunately for thousands of little sufferers, obtained for himself and his operation, the recognition of the medical men of this and other countries that it deserves.

INDICATIONS FOR INTUBATION.

A diagnosis by exclusion of all other possible causes for the condition should first be made. The chest and neck should be exposed, as in some cases the dyspnoea may be produced by external pressure, the result of abscess or cervical tumors. The lungs should be carefully examined, as capillary bronchitis atelectasis, broncho-pneumonia, deposits of pseudo-membrane in the bronchi or some other pulmonary complication may be present. The condition of the fauces should be noted, post pharyngeal abscess or excessive tumefaction of the tonsils with closure of the nares may be the cause of the dyspnoea, in which case the voice and cough will not be affected.

Some writers have urged the use of the laryngoscope to determine the condition; if such an examination could be made without the use of force, the actual demonstration of the stenotic condition and the presence of the laryngeal membrane might be desirable, although careful consideration of the physical signs could hardly fail to locate the trouble.

Extreme restlessness, long continued in children, affected by marked dyspnoea, is an indication, if consciousness be impaired, that there is undoubtedly laryngeal stenosis.

Intubation should be performed when continued dyspnoea is present from any laryngeal cause, unless it result from the presence of a foreign body, in which case the special tubes designed for that purpose may be used. Dr. O'Dwyer believes that the foreign body tube adapted to the age of the patient will allow any foreign body which has passed into the larynx to pass out through the tube, unless the body is absorbent in its nature, when the tube could hardly prove satisfactory as the size of the body would increase very rapidly after passing into the trachea.

The intubation should be performed at the very first onset of the suffocative stage, as indicated by sinking in of the yielding portions of the chest, lower ribs and sternum, episternal notch, and supra-clavicular region, with downward motion of the larynx on inspiration, and sinking of the epigastric region. The amount of sinking being proportionate to the stenosis present and simply proving that sufficient air cannot enter the lungs to fill the vacuum created by the expansion of the chest, and that recession occurs as a result of atmospheric pressure. Under such conditions the respiratory murmur over the posterior portion of the chest is very feeble or entirely absent. The operation should not be delayed until abiding cyanosis is present, or until that peculiar condition of paleness of the surfaces, indicating excessive determination of blood to the lungs appears. The carbonic acid poisoning resulting from said conditions seriously complicates the disease.

SYMPTOMS.

The characteristic symptoms of stenosis are the croupy cough, nearly always present, the noisy or croupy breathing, increasing as the disease develops, hoarseness coming on early in the disease, considerably preceding all other symptoms and developing as the disease progresses, until nearly complete aphonia is produced. Membrane about the vestibule of the larynx, tonsils and pharynx, or below the larynx in the trachea may seriously interfere with respiration, without in any way affecting the cough or voice sounds. Dyspnœa unless spasmodic is always a late and a very grave symptom. It may affect inspiration only, or both inspiration and expiration may be difficult. Expiration may be more effected than inspiration when emphysema may result. Impediments in the larynx generally produce greater difficulty on inspiration than expiration. In a patient seen for the first time when moribund or nearly so, presenting no symptoms but the extreme cyanosis and labored breathing, it may be difficult to determine the true cause of the condition; foreign body being excluded, and the physical signs present, locating the trouble in the larynx, indicate immediate intubation, regardless of the exact nature of the obstruction. Return of dyspnoea after the tube has been introduced and the patient doing well for some time, indicates some complicating condition and demands the immediate presence of the operator. The patient may be progressing favorably and the membrane clearing from the fauces, when complications or sepsis may supervene and the exudation reappear with accompanying increase in the laryngeal infection.

Coughing out the tube indicates a decrease in the œdema from pressure. It may be left out if the dyspnœa does not immediately call for its re-introduc-

tion, as the patient will probably not require it for some hours, and will certainly receive as much benefit as though the tube were constantly in the glottis, especially if the intervening periods are long and comfortable, and allow the patient to take nourishment without difficulty. Disturbing dyspnoea should be immediately relieved by re-intubation.

Sudden dyspnoea with occlusion of the tube causing asphyxia is almost certainly followed by its expulsion, although death has occurred from this cause. Unless the tube is removed or expelled in a minute or less, death will ensue.

Loose membrane in the trachea is indicated by a peculiar rasping cough, with occasional sudden closure of the tube on expiration, which signifies the necessity for preparation to remove the tube quickly in case of occlusion.

If the dyspnoea is due to subglottic, or tracheal œdema or membrane, the relief after intubation is only apt to be partial and not complete, as it always is for the time being when the obstruction is confined to the larynx.

ADVANTAGES OVER TRACHEOTOMY.

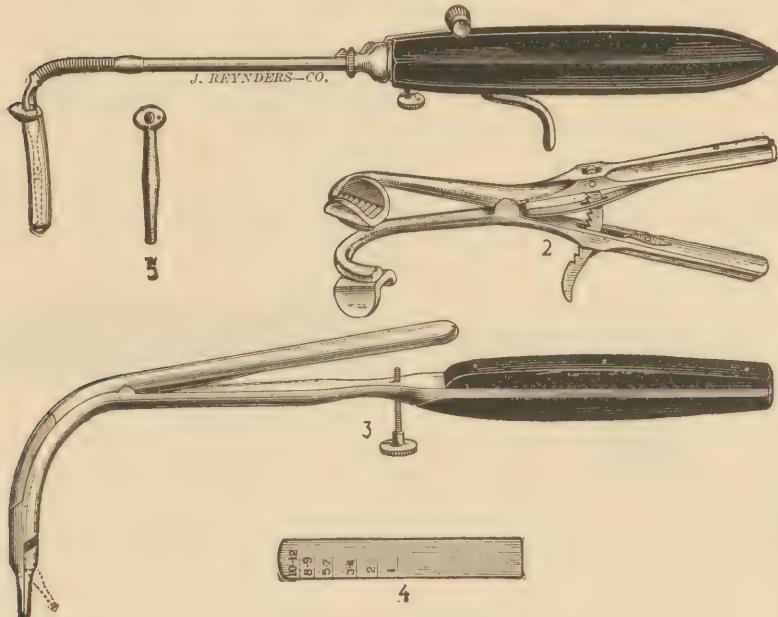
1. No anæsthetic is required.
2. The operation should be easily performed, after a careful study of the literature, and frequent trial on the cadaver, by any practicing physician.
3. There is comparatively little danger and no shock.
4. The advantage to the practitioner of being able to perform the operation alone, without trained assistants.
5. The patients are more readily induced to permit an operation which requires no cutting and is not attended by bleeding.

6. The percentage of recoveries is greater, especially in cases under three years of age.
7. There is no wound that may permit absorption and be a source of constitutional infection.
8. Is susceptible of use in mild cases of croup, which seem likely to continue as such, in which tracheotomy would be too severe a remedy.
9. Parents are gratified for the relief of the dyspnea, as the result of so moderate a procedure, even if the patient die.
10. Intubation can be better used when accommodations are poor and attention indifferent, as the tube requires comparatively little care.
11. The ability to speak and breathe quietly, and the comfortable tolerance of the tube.
12. The contact of the tube causes some disintegration of the false membrane, hastening its disappearance and preventing its re-formation; this pressure also has a decided tendency to diminish oedema.
13. The tube allows the mucus and detrus to be freely expectorated, and the ability to close the glottis is retained, thus preserving the explosive quality of the cough, which renders the tube less apt to fill with membrane, or, if it should fill, assists in its almost certain expulsion.
14. The inspired air is always warm and moist from its passage through the natural channels.
15. Deep ulceration is not apt to occur, and the superficial ulceration is not of serious moment.
16. Does not preclude subsequent tracheotomy.
17. May be used to replace a tracheotomy canula in case of obstructing granulations or tissue in the larynx.

INSTRUMENTS.

The O'Dwyer tubes for children, under the age of puberty, were originally, and are still made of brass, heavily gold plated, six in a set, from $1\frac{1}{2}$ to $2\frac{5}{8}$ inches in length, each fitted with an obturator, attachable to the introducer.

PLATE NO. II.



Correct set of croup-tubes.

In the same case with the tubes, Plate II, for use in connection with them, are the introducer, Plate II, No. 1; the mouth gag, Plate II, No. 2; the extractor, Plate II, No. 3, and the scale, Plate II, No. 4. In addition, there are now manufactured two other distinct sets of tubes, one set of ten, each tube being three inches in length, for use in stenosis of the larynx in adults. These tubes are of the same shape as the set for children, but of

larger size. They may be made of brass, gold plated, or of hard rubber, either having some special advantage over the other. The third set is for use in children, for the removal of foreign bodies and loose membrane in the trachea and bronchi; seven tubes of the same length, $1\frac{1}{8}$ inches, but differing in size with the age of the patient. They are straight, cylindrical, and slightly decreased in size of calibre at the lower end, made of very thin German silver, with no retaining swell, as they are only intended for use for short periods of time, and are held in position by the pressure of the parts.

PLATE NO. III.



Set of tubes for foreign bodies or loose membrane in trachea and bronchi.

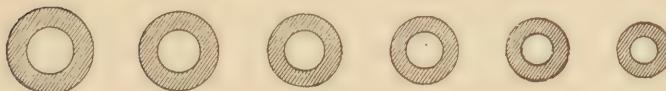
The introducer for the foreign body tubes is made upon the same principle as the one used with the children's set. It has, however, a longer curve, and instead of two flanges to release the tube, it has a single flange behind, which runs along a groove in the head of the obturator.

In the selection of a set of tubes it is necessary to take all possible precaution to have them correct in style, and

of the latest and most approved pattern. A careful consideration of the following suggestions will be helpful:

First. That the workmanship and material are of the first quality, and that there are no checks or rough points to encourage the accumulation of secretions.

PLATE NO. IV.



J. REYNNDERS—CO.



Cross-section of tubes, natural size, before and after being hammered on a mandrel.

That a hole of the requisite size is first drilled through a solid rod of brass, which is then placed on a mandrel and hammered until the lumen of the tube antero-posteriorly is about twice its lateral diameter, which is the shape least likely to produce pressure on the vocal chords.

Second. That the head of the tube, which is made separately, is oval, correct in shape and size, and that the edges throughout are carefully rounded off and smooth, that they may not cut into the tissues. The eyelet for threading the guarding string is drilled just to the left of the anterior edge, and does not enter the lumen of the tube.



Head of tube.

Third. That the upper end of the tube is rounded off, and thrown backwards by removing near the head of the

tube a triangular section, with the base of the triangle at the posterior edge of the tube, then hammering the edges of the triangular space together and soldering them in that position. This throwing backwards of the upper end of the tube can be demonstrated by laying the anterior edge of the tube on a flat surface. It is for the purpose of removing pressure from the base of the epiglottis.

Fourth. That the tube be constructed with a retaining swell, to belly-out laterally at the centre, and having the shape of a double wedge, which assists in maintaining its position in the larynx, and in preventing its expulsion during coughing.

Fifth. That the lower end of the tube is very carefully rounded off and the sharp edges entirely removed, and that the anterior edge is thickened to prevent ulceration of the anterior wall of the trachea, from the up and down movement of the tube during deglutition. The probe point of the obturator must fit the tube so accurately that no edge is left to detach membrane during its insertion.

The obturators, one for each tube, are made to screw on to the introducer, to accurately fit the tube at its head, and extend into it sufficiently to prevent its wobbling antero-posteriorly; to be jointed in the centre of the shank to facilitate removal after the tube is in the larynx; to have the greatest diameter of the bulbous tip fit exactly at the inferior edge of the tube, thus presenting a perfect probe point; to have the long diameter of the top exactly parallel with the handle of the introducer, to prevent difficulty in

PLATE
NO. VI.



Tube in rough,
after removal of
wedge-shaped
piece.

PLATE
NO. VII.



Lower end of
tube, showing
the rounded and
thickened ante-
rior edge.

releasing the tube. In case the instruments are much worn, it may be necessary to use a paper washer to make a perfect adjustment between the introducer and the obturator.

PLATE
NO. VIII.

The introducers, Plate II, No. 1, are manufactured in parts, easily detachable, which permits thorough disinfection and cleansing. The one for intubation has two flanges at the side, movable from the handle of the instrument, for releasing the tube; the one for foreign bodies has a single flange behind.

The extractor, Plate II, No. 3, is so constructed that its duck-bill, when closed, is smooth, round and probe-pointed, to prevent injury to the softened, inflamed laryngeal tissues; the bill farthest from the operator is the fixed point continuous with the handle; the movable bill opens towards the handle to facilitate the removal of the tube and prevent slipping; a set-screw is placed on every instrument to prevent possible excessive opening and laceration of the parts during efforts at the removal of the tube.

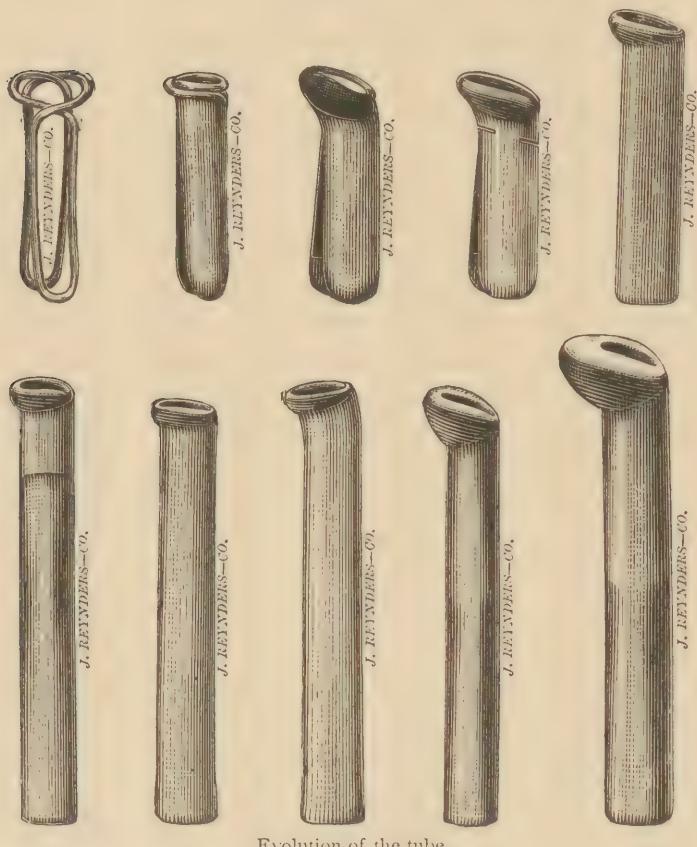
The mouth-gag, Plate II, No. 2. The most useful and best mouth-gag is the modification suggested by Dr. Denhard, of New York. It has been adopted and is recommended by Dr. O'Dwyer in consequence of there being no liability of its being displaced by the shoulder, if the patient is restless during the operation.

The scale, Plate II, No. 4, is an arbitrary measure which indicates the size of the tube ordinarily required at a given age; the measurement of the tube is to be made entire from the distal to the proximal end. There are many faulty and poorly-constructed instruments and tubes on the market, and some useless and impractical modifications.



The importance of having instruments perfect in every detail cannot be overestimated. In order that a proper armamentarium may be secured, buy only from makers of repute. Many of the best manufacturers have adopted

PLATE NO. IX.



Evolution of the tube.

the plan of having the instruments approved by Dr. O'Dwyer himself.

It is necessary to have more than one set of tubes, or the tube you require may be in use, or may accidentally

pass into the stomach just at the critical moment and the life of the patient be lost.

Instruments should be kept perfectly clean, be properly disinfected after each case, and always kept in a state of perfect readiness for operation at short notice. There have been a considerable number of modifications of the O'Dwyer tubes. Most of the modified tubes are constructed on some principle previously tried and abandoned by Dr. O'Dwyer.

The tube in present use is undoubtedly best adapted for intubation and overcomes most of the objectionable features, urged against the operation.

The evolution of the O'Dwyer tube is shown in the accompanying Plate No. IX. These tubes, with the exception of the first, a simple wire frame (used only on the cadaver,) have been successively used and abandoned by Dr. O'Dwyer. The last tube shown being the one at present in use.

This plate and the others representing the details of the manufacture of the tubes are taken from an article by Dillon Brown, M. D., of New York.* This article gives a minute description of the process of manufacture and a complete table of the different measurements of each sized tube.

An ingenious contrivance devised by Dr. Waxham, of Chicago, was a tube with an artificial epiglottis; it did not, however, as was expected, entirely prevent the passage of fluids into the trachea, and seriously complicated the removal of the tube. It is believed to have been abandoned by Dr. Waxham who advocates the posture method of feeding.

The necessity for the tube with jointed head, intro-

*The construction of the O'Dwyer tubes Archives of Pediatrics, Philadelphia, January 1891.

duced by Dr. O'Dwyer, which was intended to enable the trained nurse to remove it quickly on the appearance of sudden dyspnoea, is very much lessened since the removal of the tube by the pressure method has been suggested by Dr. Cheatham, of Louisville.

INTRODUCTION.

In some of the cases intubated, the operation is perfectly easy to accomplish; its difficulty and the necessity for experience, judgment and skill are more apparent when some of the accidents occur, and the life of the patient is temporarily jeopardized. Force is never justifiable in introducing the tube, except when a positive diagnosis of extreme subglottic infiltration of the mucous membrane is made, in such cases it is sometimes necessary to use a smaller tube than indicated by the age of the patient and to use considerable force in placing it in position.

It is extremely important that every operator should have made especial preparation to perform intubation by its careful study and practice on the cadaver, or as Dr. O'Dwyer suggests, opportunity for intubation post mortem being unattainable, to make use of the larynx of one of the smaller animals placed in the neck of a bottle, and the tube repeatedly passed, entirely by the sense of touch, unless an obstruction be encountered, when a careful note of the obstruction should be made and the procedure repeated. The subsequent progress of the case often depends upon the rapidity, delicacy, and skill

PLATE NO. X.



Tube with jointed head, which enables a trained nurse to remove it quickly in case of emergency.

used in performing the operation, several abortive efforts at introduction of the tube are much better for the patient than one prolonged, exhausting trial, the actual introduction of the tube should not require more than from five to ten seconds.

The operator and two assistants are necessary in performing intubation. Untrained assistants, if fairly intelligent may be relied upon; one assistant holds the patient seated firmly on the lap, with the head placed high up on the left shoulder, and the hands held down at the side, or the body and arms wrapped about with a sheet or towel to prevent interference with the operator. The hands should not be loosened until the string has been removed; the other assistant stands behind grasping the head of the child and slightly elevating the chin. The head must not be thrown too far back, as the tube may be arrested by coming in contact with the anterior wall of the larynx or trachea. The operator stands immediately in front of the patient and first introduces the mouth gag, gently and not too rapidly, well back in the mouth between the teeth on the left side; it is retained by the assistant, or the pressure of the jaws upon it. If the gag is not used, the operator's finger must be protected by a strip of adhesive plaster or a metal ring; if the patient has no bicuspid teeth the use of the gag or plaster is unnecessary.

If the symptoms indicate the presence of loose membrane in the trachea, introduce a small sized tube for the age, and thus favor its expulsion by coughing, in case it should become occluded. The introducer is lightly held in the right hand with the obturator attached, and the tube on the obturator threaded with a strong piece of braided, well-waxed thread, eighteen inches in length, and hooked over the little finger to prevent its passing into the stomach in case of accident.

The index finger of the left hand is passed into the pharynx, drawing forward the epiglottis, moving it slightly to the right and fixing it against the base of the tongue. The tube is then passed gently and quickly into the larynx, the finger being used as a guide. The handle of the introducer should be held lightly between the fingers and thumb exactly in the median line and well down towards the chest until the apex of the tube reaches the larynx, when the curve is changed by rapidly raising the handle, the tube is then passed into the larynx, and well down into position before it is released ; the finger should be placed on the head of the tube to prevent its coming out with the obturator as it is withdrawn.

If the tube passes into the oesophagus, and this is recognized before the obturator is withdrawn, the tube should be immediately removed, as the position cannot be rectified without performing the operation over again from the beginning. The string may be left attached to the tube until the irritative cough has stopped and some of the mucus and detrus is expelled ; then one strand is cut as near to the tube as possible, the index finger is placed on the head of the tube and the string gently withdrawn. It is not generally necessary to use the gag in removing the string, as the patient if old enough, is willing to get rid of it. The string may be left continuously attached to the tube, and tied around the ear or fastened to the face with a strip of adhesive plaster. In patients at the age of puberty it is well to retain the string continuously, in consequence of the rapid increase in the size of the larynx at that age.

The rasping breath immediately following the withdrawal of the obturator, the full metallic cough accompanying the operation, and produced by swallowing

liquids, with continued comfortable breathing, indicate that the tube is properly within the larynx.

In case the tube should be coughed up or removed from the larynx, the time for reintubation would be indicated by the recurrence of dyspnoea and absence of the respiratory sounds over the lower lobes of the lungs.

REMOVAL.

To withdraw the tube with the extractor, follow each step taken in the introduction, when placing the index finger of the left hand behind the epiglottis, locate the head of the tube and pushing the finger to the right of the patient to uncover its orifice, guide the tip of the extractor into it. Never undertake to use the extractor unless the presence of the tube can be demonstrated by the touch of the finger, as its presence in the larynx is doubtful if it cannot be felt. The extractor is held lightly in the right hand between the thumb and fingers; the thumb is not placed on the lever until the tip of the instrument has entered the lumen of the tube, when it is moved forward to the lever and steady pressure made until the tube is out of the mouth.

It is important that the thumb is not placed on the lever until the proper time, as the object of the operation may be defeated by unconscious pressure spreading the bills so that they cannot enter the tube, or some injury may be done to the parts by catching folds of mucus membrane or lacerating the softened and inflamed tissues.

It is sometimes difficult to succeed in entering the tube with the extractor, but cool, careful and deliberate efforts generally result in its successful removal; the use of an anæsthetic has been suggested when the patient is very difficult to manage, but it is usually unnecessary.

Removal of the tube by external pressure without the use of the extractor has been recently advocated by Dr. Cheatham, of Louisville, who writes regarding this method: "It is by far the easiest method of removing the tube and is generally successful, although in my last case it failed entirely, and I was obliged to resort to the extractor. The patient was very fractious and the neck so short that I did not seem to get below the tube to press it upwards; there was also considerable œdema of the parts and the tube itself was full large for the case. The procedure is very simple—with the left hand in the mouth and the right thumb on the trachea, push upwards and backwards; when well out of the larynx throw the patient's head forward and the tube will fall to the floor."

The left index finger in the pharynx must be hooked behind the tube as it passes out to prevent its passage into the posterior nares. Removal of the tube by an electro magnet has been suggested but has not as yet been reported successful.

The time for removal of the tube and the amount of tolerance of the laryngeal tissues vary with different patients and the severity of the disease. The presence of the tube may result in a long period of comfort and relief of dyspnoea, even when it is ejected after having been within the larynx for a very short period of time. If dyspnoea does not occur in half an hour after ejection or removal of the tube, it is not apt to occur for several hours and will come on slowly. When dyspnoea returns after having been primarily relieved, remove the tube regardless of what may seem to be the cause; it may be removed and re-introduced at any time, but should not be disturbed when the patient is comfortable. There is no advantage in removing the tube to permit feeding, as the patient can feed no better with the tube removed

until the parts have accustomed themselves to the change ; the tube should be retained while the membranous deposit remains in the pharynx. In croup the tube may be retained from a few hours to twelve or fifteen days or more ; if the patient's condition indicates it, the tube should be removed in from four to six days on trial, and re-introduced again if the dyspnœa returns ; this removal is apt to be of advantage to the parts in loosening membrane, even though re-introduction subsequently becomes necessary. Dr. O'Dwyer has reported a case of specific stenosis of the larynx, in which the tube was worn for ten months and four days and the patient never seen or treated during that time.

Loose secretions in the tube that can be blown out or washed out by a stream of water do not cause serious obstruction. If the tube become occluded by loose membrane, it is almost certainly expelled, as the ability to inspire air is still present, the membrane acting as a valve, stops expiration, making the internal pressure greater at each breath ; if the tube is not expelled it must be immediately removed in some manner, or death follows at once. Placing the patient in the dorsal position, with the hand pressed firmly on the abdomen to prevent descent of the diaphragm, and striking the chest forcibly with the open hand, is suggested as a means of assisting the explosive action in such cases.

ACCIDENTS.

Accidents of a more or less moment occur with nearly every operation ; they may be tabulated as avoidable and unavoidable ; the avoidable accidents may be overcome by a thorough knowledge of the technique of the operation.

Avoidable Accidents.—

1. *False passage made in attempts at introduction*; use no force and hold the instruments lightly.
2. *Injuries to the parts in efforts at removal*; careful, steady operating will not result in material injury.
3. *Passing the tube into the œsophagus*; may happen, but it can be easily removed by the string.
4. *Asphyxia from slow accumulations of secretions in the tube*; use the steam atomizer constantly, and remove the tube if necessary.
5. *Asphyxia from prolonged efforts at introduction*; make several efforts of short duration rather than one continuous and exhausting one.
6. *Asphyxia from swelling of membrane over the tube's head, fixing it, and feeling as though the tube had passed into the trachea*; remove tube and introduce one with larger head.
7. *Slipping of tube into trachea*; will not occur and is not possible when a proper sized tube is used carefully. The subglottic construction of the larynx prevents the tube from passing below the ventricular bands, unless the circoid cartilage is split.
8. *Spasm of the glottis immediately following removal of the tube as a result of irritation of inspired air*; may be prevented by the administration of an opiate shortly before removal.
9. *Catching the thread in the eyelet hole of the tube*, may be prevented by using braided linen or silk thread well waxed.
10. *Cutting the parts in the removal of the string*, may be prevented by cutting the string as close as possible to the tube and withdrawing slowly.
11. *Lacerations made by the gag or finger during the operation*, will be immaterial if the patient is carefully handled.

Unavoidable Accidents.—

1. *The presence of partly adherent membrane.* The removal of such membrane is a difficult problem to solve, many forceps have been devised for this purpose. Dr. O'Dwyer has introduced the set of foreign body tubes to be used in such cases; the solution which is still in doubt, consists in the means of detaching the membrane that it may be expelled or removed.

2. *Pushing down pseudo membrane before the tube.* The membrane will be less apt to be pushed down in front of the tube, if it is placed well in position before removal of the obturator, and held in position during its removal, as the tube if drawn partially out may with its edge detach membrane, in being pushed back into the larynx.

3. *Fatal obstruction from membrane in or below the tube.* The tube is generally coughed up if obstructed; it must, however, be removed in some manner, or death will ensue. Always, if practical, leave the string attached in cases of this character. It is well to undertake to rid the patient of the membrane, either by introducing and withdrawing the tube, using a larger tube, or resorting to the foreign body tubes. If the patient is young there is danger of pulling at the string or of chewing it apart. the latter may be overcome if there is room, by passing the thread between the two double teeth. It may be necessary to use a small tube in order that it may be readily expelled by coughing in case of obstruction.

4. *Partial obstruction from aspiration of food or vomited matter into the bronchi.* It is very rare, if it occur at all.

5. *Coughing out the tube and swallowing it;* has occurred, and the absence of the tube was not discovered until too late or until harmful efforts at its removal with the extractor has been made.

6. Coughing out the tube or expulsion during vomiting.

This accident is not serious unless paralysis is present. The dyspnoea does not often return until the operator, who should be immediately summoned, has had time to return and re-introduce the tube, which should be one with a greater retaining swell than the tube expelled.

DANGERS.

In any operation there are dangers of greater or less moment to encounter. These dangers may or may not be susceptible of prevention. The dangers attending intubation over which the operator has no absolute control, are—

1. *The unavoidable accidents.*
2. *Shock of the operation*, which is very slight if it is rapidly and skilfully performed.
3. *Septic air passing into the lungs on inspiration.*
4. *Food and liquids entering the bronchi.* Of this danger Dr. W. D. Northrup, pathologist to the New York Foundling Asylum reports in substance as follows: "There has been no evidence of the presence of food in the finer bronchi or alveoli found in the one hundred and seven autopsies held at the asylum, and no pneumonia was present which could be fairly called *Schluck pneumonia*, aspiration, or food pneumonia, or nothing was found corresponding to the recent description reported by Orth, of Gottingen. Pneumonia was present, however, to some extent as demonstrated by obvious signs of consolidation, or the microscopic findings in about seventy-five per cent. of all the autopsies."
5. *Ulceration from pressure of the tube on the trachea* is not frequently deep enough to be of moment, but in patients who have previously suffered from exhausting

disease, ulceration may occur and easily amount to a complication, even when the tube is only worn the usual number of days.

6. *Œdema from pulmonary or glottic infection*, may result from the severity of the disease, or from local application of medicants applied on the tube; the tube itself diminishes the œdema by pressure on the parts.

7. *Hemorrhage from rupture of tracheal blood vessel.*

8. *Paralysis, septic, of the muscles of deglutition*; necessitating feeding by the stomach tube or per rectum.

The following reasons for operating for tracheotomy after intubation has failed, were tabulated by I. H. Hance, M.D., New York:

1. Intolerance of the larynx for retention of the tube.
2. Inability to administer a proper amount of nourishment.
3. Dislodgment of membrane during the operation.
4. Frequent plugging of the tube with thick mucus and shreds of membrane.
5. Passing the tube below cords with inability to extract.
6. False passage in which event tracheotomy must be performed immediately.

TREATMENT.

Intubation is only a temporary expedient to relieve a symptom. The eventual recovery of the patient must depend upon the ingestion and assimilation of a sufficient quantity of nourishing food and a proper course of medical treatment.

The medicine best adapted, and most generally used, is the bichloride of mercury, administered in large doses, grains one-sixtieth to grains one forty-eighth every hour

in a wineglass of water, from the inception of the disease, and carried to the point of salivation unless symptoms appear which counter-indicate its use.

The mild chloride of mercury is also extensively used, in small doses, grains one-half, frequently repeated; it may be placed dry upon the tongue, one powder every hour or two, washed down with small pieces of ice. Dr. J. Lewis Smith in a paper recently read before the American Medical Association, has advocated the use of the mild chloride by incineration within a tent arranged over the patient's bed. The treatment was used in the New York Foundling Asylum with marked benefit to the patient, but resulted unfortunately in the salivation of two of the nurses in attendance.

Tincture of the chloride of iron and chlorate of potash is still advocated by many practitioners. Milk and whiskey are extremely important in all cases if well borne.

Antipyretics—any of the medicines of this class may be used with good effect, if indicated by elevation of the temperature.

Brandy, camphor, caffeine, æther, aconite and belladonna, or any of the reliable cardiac stimulants may be used if the pulse shows heart failure.

Medicines may be given in such quantities as the patient is able to swallow and retain; frequent small doses properly ingested, will be preferable to large doses not well borne.

Medicines in powder may be given dry upon the tongue, accompanied by small pieces of ice to dissolve and carry them down.

Cough may be induced, in case it is necessary to carry away mucus and shreds of membrane, by liquid feeding or by the use of lime water. For several hours after the operation it is better to allow the patient only small

pieces of ice dipped out of brandy or wine, until the larynx has established its tolerance of the tube, when the medication may be commenced. A moist spray should be constantly passing through the room to prevent hardening of the mucus. Many practitioners favor the addition of some medicant to the spray.

In syphilitic stenosis it may be necessary to medicate the tube, or to increase its size at the retaining swell, or to add a retaining swell to a straight tube. This may be accomplished by successive coatings of gelatine dusted over with powdered alum, while still moist until the desired degree of thickness is obtained. A tube thus prepared has the power of absorbing moisture and increasing in size, thus assisting in the gradual dilatation of the parts, and also acting as an astringent; the rapidity of the absorption and consequent dilatation of such a tube may be controlled by the application of one or more coats of collodion.

FEEDING.

The difficulty of administering a sufficient amount of nourishment after intubation has been one of the principal objections to the operation; this objection has been practically overcome by the posture method of feeding suggested by Dr. W. E. Casselberry, of Chicago. This method of feeding is very simple, and is not followed as was at first feared, by any cerebral congestion or special discomfort. The patient is placed in the dorsal position with body on an incline plane, the head downward, the exact position varying in different cases, the angle being from twenty to forty-five degrees.

The patient is held on its back in the arms of the nurse, the legs elevated and the head hanging over the arm. The feeding may be from a feeding bottle, through

a glass tube or from a spoon. The only difficulty is encountered when the patient again resumes the upright position; that portion of the food which has gravitated into the pharynx and nostrils, then passes into the larynx and causes coughing. This can be overcome after the patient has become accustomed to the method, by having three or four efforts at deglutition made before allowing the child to rise, thus forcing the food into the stomach. The patient may be inclined in this position for a minute or more, giving ample time to ingest sufficient food, without serious inconvenience.

The feeding may be also accomplished by placing the patient on the abdomen with the head hanging forward, a method previously suggested in cases having difficulty in deglutition from tubercular ulceration of the epiglottis. This procedure is not as successful as the dorsal posture.

Feeding with a stomach tube passed through the mouth or nostrils is difficult to accomplish after the first trial, and if not accomplished in a short space of time results in vomiting. Feeding per rectum may be resorted to, if called for by the condition of the patient preventing sufficient nourishment being taken by the stomach. Feeding by inunctions of oil has been suggested as possibly of value in cases demanding more nourishment than can be given in any other manner.

For several hours after intubation allow nothing but small pieces of ice dipped in brandy or wine to be used. The cough produced by the small quantity of fluid which passes into the larynx is beneficial in causing dislodging and expelling of mucus and shreds of membrane. Pain and cough and difficulty of deglutition are present at times, but decreases as the larynx becomes accustomed to the tube and the patient learns to swallow.

The patient may be able to swallow more readily after

intubation in consequence of the relief of the dyspnœa, not having been able to take time while it was present; the ability improves with the continued presence of the tube.

It is well for the physician to instruct the nurse how to feed the child, and after careful observation to determine the manner, quantity and frequency. Whatever method of feeding is used, food may be given by the teaspoonful or even from a medicine dropper ten or twenty drops at a time. Solids and semi-solids may be swallowed without much difficulty; but fluids generally provoke cough. It is best that the food should be taken in small quantities frequently repeated rather than too much at one effort, lest the patient become discouraged by the violent coughing produced. Dr. O'Dwyer, however, recommends taking four to five swallows at once, then coughing. In some cases patients will not take the nourishment suggested, but desire some particular variety of food. If the wish is gratified, and the power of selection given, the patient may take an ample quantity of nourishment of the kind selected.

DIETARY.

Thick soup, farinaceous foods with milk, chocolate, cream, eggs, soft boiled or scrambled, frozen or condensed milk, ice cream, jellies, custards and whey. Solids chopped very fine and moistened with small pieces of ice, oatmeal, rice or barley cooked and strained, served hot or cold with cream or raw eggs and milk, sweetened to taste.

FOOD PNEUMONIA.

There is little or no evidence to indicate that food plays any part in the production of the pneumonia which so frequently complicates croup, being present

to a greater or less extent in nearly all the fatal cases; in many of the cases it is found only in a slight degree, not sufficient to have caused death. There have been reports in other countries of autopsies demonstrating the presence of food in the alveoli, but in the autopsies made in this country no evidence of food having been aspirated into the finer bronchi or air cells has been found in any of the reported cases upon which autopsies have been held. Vomited matter could hardly be a factor in the production of pneumonia, even were it proved to have been produced by aspiration, as it is not apt to enter the tube, and there is no resistance to its passage outward, as offered in the ingestion food.

PROGNOSIS.

The prognosis without operation in diphtheritic or fibrinous croup is very unfavorable; the disease results in from ninety to ninety-five per cent. of deaths. The latest statistics collected and the compilation of cases intubated indicate from sixty to seventy per cent. of deaths, or from twenty-seven to thirty per cent. of recoveries; the percentage of the recoveries is increased as the technique of the operation is more generally understood.

Important factors in the prognosis are—

1. The age of the patient.
2. Time of origin.
3. Nature and extent of the membrane, the prognosis being better when the membrane is not present in the pharynx, having been present and disappeared.
4. The presence of complications.
5. The severity and height of the epidemic; during a fatal epidemic of diphtheria, and at the height of the epidemic, the cases are proportionately more fatal from septic systemic infection.

6. From nephritis.
7. From pneumonia.
8. From greater tendency to invade the bronchial tubes.

In the early or declining period of an epidemic the fatality is very much lessened. The intubations reported with this paper, eighteen in number, with only three recoveries, were all performed during the height of the very fatal epidemic of diphtheria which occurred at Paterson, N. J., in the winter of 1890 and 1891. This epidemic was attended by an unusually large percentage of deaths, as shown in the following table furnished by J. L. Leal, M. D., Health Officer. The intubations were all made between July, 1890, and February, 1891, when, in seven months 259 cases of diphtheria were reported with 103 deaths.

NO. OF CASES OF DIPHThERIA AND DEATHS REPORTED DURING THE YEARS 1890-1891.

Month.	No. of Cases.	Diphtheria.	Croup.
		No. of Deaths.	No. of Deaths.
<i>1890.</i>			
January.....	11	4	During the time
February.....	3	0	of intubation
March.....	10	1	of cases here- in reported.
April.....	11	4	....
May.....	10	4	....
June.....	10	4	....
July.....	13	5	....
August.....	19	5	1
September.....	33	14	3
October.....	59	17	3
November.....	40	16	2
December.....	52	16	3
Total	271	90	....
<i>1891.</i>			
January.....	43	18	....
February.....	21	2	....
March.....	21	12	....
April.....	33	15	....

Many of the deaths due to croup are reported as caused by diphtheria, no special clinical note of the croup being made. This neglect on the part of the physician in reporting the cases nullifies the comparative value of the statistics.

The prognosis is worse under the following conditions:

1. When the patient is young.
2. When no membrane has yet invaded the fauces or has only recently appeared.
3. When the septic poisoning is very well marked.
4. When complicating conditions are present, fibrinous bronchitis, extending from the seat of the disease; nephritis, which is likely if present to be in proportion to the severity of the disease, with scanty secretion of urine containing large quantities of albumen and blood; pneumonia which may develop at any time, but generally comes on in the later stages.
5. When there is loss of appetite and disgust of food, complicating conditions are almost always present.
6. When high temperature comes on the second or third day after intubation.
7. When an increase in the respirations occurs, they may run up from forty to one hundred per minute, according to the age of the patient; such an increase would indicate diminution in the calibre of the tube or the presence of pneumonia.
8. When the disease comes on very rapidly and violently with excessive membranous deposits of dark color and foul odor with great tumefaction of the cervical glands and softening of the tissues in the pharynx and larynx.
9. When the stenosis comes on rapidly and the laryngeal symptoms have not been present for a considerable time before intubation was necessary.

10. When the epidemic is at its height the prognosis is more grave than it would be earlier, or later when the epidemic was on the decline.

11. When severe asphyxia, long continued before the operation could be performed, has been present producing a rarefaction of the air in the lungs with subsequent exhaustion, more or less atelectasis, collapse of the lung tissue, dilatation of the blood vessels, disturbance of the pulmonary circulation and resulting carbonic acid poisoning.

CASES.

The eighteen cases here tabulated would have undoubtedly resulted much more favorably had the operations not been performed during so severe an epidemic of diphtheria, in which the sepsis was so great and the complications so frequent as to have resulted in about forty per cent. of deaths in all the diphtheritic cases reported to the Board of Health. The tube was a source of relief and comfort in nearly every case operated, was well borne, and did not present in any case an insurmountable barrier to the administration of considerable quantities of nourishment. In addition to the three cases which recovered, at least three more should have resulted favorably had the disease been attended only by its customary malignancy. Even though the percentage of recoveries should be smaller than it usually is, the comparative comfort of the patient and the relief of the dyspnoea would recommend intubation to the favorable consideration of medical men in general.

DATE.	IN THE PRACTICE OF	SEX.	AGE.	DURATION OF DISEASE IN PARANODAL SYMPTOMS.	TYPE OF DISEASE.	CAUSE OF DEATH.	COMPLICA- TIONS.	RESULT.
July, 1890	1 Dr. Satalino.	Female.	18 months.	24 hours.	5 days.	Sepsis.	Carbonic acid poisoning.	Died 5 hours after intuba- tion.
Aug., 1890	2 Dr. J. L. Leal.	Male.	2 years.	8 hours.	3 days.	Extension to Bronchi.	Tube coughed up into nares.	Died 12 hours after intuba- tion.
Aug., 1890	3 Dr. J. W. Smith.	Female.	12 years.	12 hours.	1 week.	.....	.....	Recovery; tube remained 2½ days after intuba- tion.
Sept., 1890	4 Dr. T. J. Kane.	Female.	2 years.	18 hours.	4 days.	Meningitis.	Convulsions.	Died 4 hours after intuba- tion.
Sept., 1890	5 Dr. J. S. Bibby.	Male.	5 years.	36 hours.	2 weeks.	Extension to Bronchi.	.....	Died 33 hours after intuba- tion.
Sept., 1890	6 Dr. B. C. Magennis.	Male.	4 years.	3 days.	10 days.	.....	.....	Recovery; coughed up tube 6 days after intuba- tion.
Sept., 1890	7 Dr. Doty.	Male.	5 years.	24 hours.	6 days.	Extension to Bronchi.	Sudden heart failure.	Died 12 hours after intuba- tion.
Sept., 1890	8 Dr. P. A. Harris.	Female.	7 years.	18 hours.	7 days.	Pneumonia.	.....	Died 5 days after intuba- tion.
Sept., 1890	9 Dr. Wm. Blundell.	Female.	9 years.	24 hours.	4 days.	Sepsis.	Gastritis.	Died 3 days after intuba- tion.
Oct., 1890	10 Dr. C. P. Townsend.	Female.	5 years.	26 hours.	5 days.	Sepsis.	Carbonic acid poisoning.	Died 27 hours after intu- bation.

DATE.	IN THE PRACTICE OF	SEX.	AGE.	DURATION OF SYMPTOMS.	CAUSE OF DEATH.	COMPLICA-TIONS.	RESULT.
Oct., 1890 11	Dr. Wm. Blundell.	Female.	4 years.	14 hours.	4 days.	Heart failure.	.....
Nov., 1890 12	Dr. Henry Parke.	Female.	8 years.	12 hours.	4 days.	Exhaustion.	Died 2½ days after intu-bation.
Dec., 1890 13	Operated by Dr. Parke.	Female.	5 years.	10 hours.	4 days.	.....	Recovery; tube coughed out 6 days after intuba-tion.
Dec., 1890 14	Dr. P. A. Harris.	Female.	6 years.	8 hours.	12 days.	Dyspnoea, the tube having been removed.	Died; the tube did not relieve her.
Dec., 1890 15	Dr. T. J. Kane.	Female.	4 years.	7 hours.	2 days.	Convulsions.	Scarlet fever. Died 2 days after intuba-tion.
Dec., 1890 16	Dr. Wm. Blundell.	Female.	2½ years.	9 hours.	8 days.	Exhaustion.	.....
Jan., 1891 17	Dr. Wm. Blundell.	Male.	5 years.	28 hours.	3 days.	Sepsis.	Died 1 week after intuba-tion.
Jan., 1891 18	Dr. Wm. Blundell.	Female.	7 years.	3 hours.	8 days.	Asphyxia.	Died before the tube could be introduced.

CONCLUSIONS.

Intubation to be successfully performed depends upon—

1. The use of properly constructed instruments.
2. The skill and judgment of the operator.
4. The delicacy of the operation.
4. The thorough and complete knowledge of the requisite medical treatment.
5. The proper feeding and care.
6. The variety of the disease.
7. The severity and period of the epidemic.
8. The extent and number of the complications.
9. The careful examination of the patient at frequent intervals, and preparations to combat complications, or obstruction of the tube.

Intubation may be performed quickly under almost any circumstances in which tracheotomy is desirable, and also many times when tracheotomy is undesirable or impossible. The severity of the disease, the age and condition of the patient, the complications, the surroundings, the cause of the dyspnœa, no matter what the extent, do not militate against the operation. It may be performed early or late in the disease, and should be performed in all cases, even when apparently hopeless, to give comfort to the patient by preventing asphyxia, and give the possible chance of recovery.

The posture method of feeding has relieved the operation of one of the most objectionable features.

The pressure method of removal of the tube has relieved the operation of its most difficult procedure.

The presence of the tube in the larynx must be demonstrated by the sense of touch before the extractor is used.

The tube must be removed at once if not expelled on

the onset of sudden dyspnœa, and should be removed on trial if dyspnœa return after having been relieved.

The percentage of recoveries has increased as the operation grows older and the operators more skillful.

No evidence of the production of pneumonia by the aspiration of food has been noted in autopsies made in this country.

Tracheotomy should be performed when intubation fails. It is desirable for every intubator to have at hand the instrument for trachotomy in case one of the unavoidable accidents should necessitate the operation.

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